

JPRS 80336

17 March 1982

USSR Report

ENGINEERING AND EQUIPMENT

No. 84

FBIS FOREIGN BROADCAST INFORMATION SERVICE

NOTE

JPRS publications contain information primarily from foreign newspapers, periodicals and books, but also from news agency transmissions and broadcasts. Materials from foreign-language sources are translated; those from English-language sources are transcribed or reprinted, with the original phrasing and other characteristics retained.

Headlines, editorial reports, and material enclosed in brackets [] are supplied by JPRS. Processing indicators such as [Text] or [Excerpt] in the first line of each item, or following the last line of a brief, indicate how the original information was processed. Where no processing indicator is given, the information was summarized or extracted.

Unfamiliar names rendered phonetically or transliterated are enclosed in parentheses. Words or names preceded by a question mark and enclosed in parentheses were not clear in the original but have been supplied as appropriate in context. Other unattributed parenthetical notes within the body of an item originate with the source. Times within items are as given by source.

The contents of this publication in no way represent the policies, views or attitudes of the U.S. Government.

PROCUREMENT OF PUBLICATIONS

JPRS publications may be ordered from the National Technical Information Service (NTIS), Springfield, Virginia 22161. In ordering, it is recommended that the JPRS number, title, date and author, if applicable, of publication be cited.

Current JPRS publications are announced in Government Reports Announcements issued semimonthly by the NTIS, and are listed in the Monthly Catalog of U.S. Government Publications issued by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Correspondence pertaining to matters other than procurement may be addressed to Joint Publications Research Service, 1000 North Glebe Road, Arlington, Virginia 22201.

Soviet books and journal articles displaying a copyright notice are reproduced and sold by NTIS with permission of the copyright agency of the Soviet Union. Permission for further reproduction must be obtained from copyright owner.

17 March 1982

USSR REPORT ENGINEERING AND EQUIPMENT

No. 84

CONTENTS

NUCLEAR ENERGY

Atomic Heating Plant for Remote Regions.....	1
Problems in Technical-Economic Analysis of Atomic Electric Power Plants With Fast Reactors.....	2
Systems Analysis Method for Improving Fast Reactors.....	3
Systems Approach to Optimizing Fast Reactor Parameters.....	3
Interrelation Between Initial and Steady States of Fast Reactor With N ₂ O ₄ Coolant During Refueling.....	4

NON-NUCLEAR ENERGY

Soviet Scientist Sees Vibration Resonance as Source of Future Technology.....	5
--	---

INDUSTRIAL TECHNOLOGY

Control Algorithms for Sensitized Manipulator.....	8
Layout and Design of Device for Forced Fit Setting in Differential Transmissions of Manipulators.....	8
Some Problems in Computer-Aided Industrial Robot Design.....	9
Valve Design for Maximum Flow Rate.....	10
Introduction of Machine Tools With Programmed Digital Control in Heavy Machinery Manufacturing Industry.....	10
Outlook for Introducing Automatic Manipulators in Heavy Machinery Manufacturing Industry.....	11

Straightening Bent Turbine Runner Shafts by Regulated Thermal Shock Method.....	11
Robots Today and Tomorrow.....	12
Machining Accuracy on Lathes With Numerical Preset Control.....	13
Speed of Adaptive Miller Control System.....	14

TURBINE AND ENGINE DESIGN

Estimation of Carrying Capacity of Cast Turbine Runners From Equivalent Acceleration Tests.....	15
State of Thermal Stress in Radial Turbine Stage Runner.....	16
Coefficient of Heat Transfer in Condensers of Steam Turbines.....	16
Carrying Capacity of Active Compressor Runners for Aircraft Gas-Turbine Engines Under Short Cyclic Load at Normal or Higher Temperatures.....	17
Technology of Reduction of Enlarged Radial Clearances in Turbine Seals.....	18
Calculating Load-Bearing Frames of Gas Turbine Engines: Report 1.....	18
Calculating Load-Bearing Frames of Gas Turbine Engines: Report 2.....	19
Comparative Analysis of Gas Turbine Engine Compressor Blade Durability.....	19

NAVIGATION AND GUIDANCE SYSTEMS

Application of Matrix Calculus to Space Flight Dynamics Problem....	21
---	----

HIGH-ENERGY DEVICES, OPTICS AND PHOTOGRAPHY

Local Strains in Continuous-Surface Mirrors and Their Frequency Dependence.....	22
---	----

FLUID MECHANICS

Cone Drag in Cavitation Flow.....	23
Hydrodynamic Drag of Plates and Shells.....	23

MECHANICS OF SOLIDS

Thermoelastic Stresses in Cylinder of Material With Temperature-Dependent Physicomechanical Properties.....	25
Nonaxisymmetric Problem of Heat Conduction for Short Cylinder.....	25
Thermoelastic Behavior of Prismatic Body Under Short Action of Nonuniform Heat Sources.....	26
Thermoelasticity in Multilayer Plates and Shells with Finite Rigidity.....	26
Electroelasticity Relations for Piezoceramic Shells Polarized Along One Coordinate Axis.....	27
Experimental Study of Longitudinal Flexure of Imperfectly Shaped Cylindrical Shells.....	27
Thick-Walled Cylinder Under Linearly Varying Pressure.....	28
Algorithm of Calculating State of Deep Shells of Revolution With Large Axisymmetric Displacements.....	28
Solvability Proof for Problems in Theory of Orthotropic Shells of Revolution With Finite Rigidity.....	29
Fatigue and Stability of Shells of Revolution Under Cyclic Thermomechanical Load.....	29
Stability of Reinforced Conical Shells.....	30
Computer-Aided Numerical Simulation of Certain Classes of Problems Pertaining to Flexible Shells of Intricate Shape.....	30
Theory of Anisotropic Shells and Plates.....	31
Solving Contact Problems in Shell Theory by Asymptotic Integration Method.....	32
Designing Compound Shells of Revolution for Large Displacements....	32
Critical Pressure for Sharply Convex Asymmetric Sandwich Shell.....	33
Stresses and Displacements in Cylindrical Shells Under Local Load.....	33
Experimental-Theoretical Study of Dynamic Characteristics of Conical Shells Reinforced With Variable-Stiffness Stringers.....	34

Stability of Conical Shell Under Compound Load.....	34
Stressed State in Hole Zone Under Shrouds of Steam Turbine Blades..	35
Experimental Evaluation of Shape Imperfection and Carrying Capacity of Hemispherical Glass Shells.....	35
State of Thermoelastoplastic Stress in Open Shells of Revolution Under Nonaxisymmetric Mechanical and Thermal Loads.....	36
Nonaxisymmetric Longitudinal-Transverse Deflection of Cylindrical Shells Under Combined Pure Flexure and Pressure.....	36
Predicting Breaking External Hydrostatic Pressure on Spherical Glass Shells.....	37
Possible Mode of Vibration Excitation in Compressor Blades.....	37
Natural Vibrations of Rhomboidal Cylindrical Panels.....	38
Stability and Carrying Capacity of Longitudinally Branching Cylindrical Shells Under Central or Eccentric Compression.....	39
Stability of Cylindrical Shell Under External Pressure and Nonuniform Heating.....	39
Strength and Damageability of Compound Glass Shells With Various Types of Separable Connections.....	40
Approximate Mathematical Models for Stability Problems Pertaining to Nonhomogeneous Shells.....	41
Parameters of Optimum Reinforcement for Cylindrical Shell Within Zone of Concentrated Action.....	41
Influence of Ambient Temperature on Rational Design of Dynamic Vibration Dampers With Viscoelastic Coupling.....	42
Transmission of Torque to Shell Through One-Dimensional Inclusion.....	42
Determining Contact Zone and Contact Stresses in Pair of Internally Tangent Cylinders.....	43
Natural Frequencies and Modes of Reinforced Axisymmetric Shells....	44
Particulars of Strain and Fracture When External Pressure Acts on Cylindrical Plate Glass Shells With Ends Cemented in Grooves of Rigid Disks.....	44

TESTING AND MATERIALS

Longitudinal High-Frequency Vibration Amplitudes and Corresponding Mechanical Stress Levels in Piezoceramic Cells.....	46
Comparative Study of Glass-Enamel Coatings for Thermotechnical Applications.....	46
Characteristics of Turbine Stages With Medium Fan-Out and Reduced Reactivity Gradient.....	47
Strength of Rotating Disks Made of Composite Materials.....	48
Effect of Magnetization on Interaction of Rubbing Surfaces.....	48
Glass-Enamel for Protecting Power Equipment Against Corrosion.....	49
Selecting Tool and Coolant for Grinding Titanium Alloys.....	49

ATOMIC HEATING PLANT FOR REMOTE REGIONS

Moscow TEPLOENERGETIKA in Russian No 12, Dec 81 pp 42-45

TSYKANOV, V. A., doctor of technical sciences, ALEKSENKO, Yu. N. (deceased), doctor of technical sciences, TOKAREV, Yu. I., candidate of technical sciences, RYUMIN, V. P., engineer, VOLZHANKIN, V. V., engineer, MONCHINSKIY, A. G., engineer, KUKLIN, A. N., engineer, POLIVANOV, I. F., engineer, and GRACHEV, A. L., engineer

[Abstract] An atomic central heating plant has been designed for service in industrial and residential regions of the Far North and the North-East. It consists of two independent units, each with a reactor and three loops. The coolant is ditolyl methane, with high boiling point and low equilibrium reactivity, in the first and second loops. The coolant in the third loops is station water. Each reactor housing is made of 20 mm thick carbon-steel strip, capable of withstanding pressures up to 0.8 MPa maximum in the second loop. There are 136 cassettes inside, each containing concentrically arranged intermetallide fuel elements 2 mm thick and 2.5 mm apart, the entire core being 110 cm high and 106 cm in diameter. In each cassettes is also a stationary displacer-absorber, gadolinium in the inner 54 cassettes and photoneutron beryllium sources in the outer 80, as well as 27 movable absorber rods. The reactor power, nominally 30 MW, can be regulated either automatically with these movable control rods or automatically through a negative temperature coefficient of reactivity. In addition to heat exchangers, the auxiliary equipment includes compensators, degassers, purifiers, pumps and valves. Most components, wherever possible, are made of carbon steel. Around-the-clock operation in four shifts is planned, with a staff of 50 including the repair and maintenance crew. Figures 2, tables 2. [112-2415]

PROBLEMS IN TECHNICAL-ECONOMIC ANALYSIS OF ATOMIC ELECTRIC POWER PLANTS WITH FAST REACTORS

Minsk IZVESTIYA AKADEMII NAUK BSSR: SERIYA FIZIKO-ENERGETICHESKIKH NAUK
in Russian No 4, Oct-Dec 81 (manuscript received 29 Oct 80) pp 24-27

SMOLKIN, Yu. V. and SUVOROV, P. P., Scientific-Industrial Association for Study and Design of Power Engineering Equipment imeni I. I. Polzunov

[Abstract] Technical-economic analysis of atomic electric power plants with fast reactors, for the purpose of their optimum expansion, must take into account fuel availability and cost projections as well as the option of using secondary fuel obtained by reprocessing. An important optimality criterion is the nationwide economic effect, rather than the local one, of changes in the energy production due to addition of a new power plant. The problem of designing an optimization model of nuclear power development reduces to a "two-point" well conditioned multivariate problem in dynamic programming which must be consistent with the indeterminacy of information about the final state of the system. The degree of this indeterminacy increases as the forecasting range becomes longer and some of it is inevitable even when the model is constructed on the basis of the initial conditions (costs) in a quasi-optimum plan. Optimization is, furthermore, possible on the basis of the maximum specific effect in "base" costs per unit cost of the limiting item. The limiting item which determines the economic effectiveness of an atomic electric power plant with fast reactor can be, for example, the steam generator or the nuclear fuel. This is illustrated here on the design of reactor shields, on which the differential cost of plutonium will depend. According to calculations based on US prices of plutonium, movable lateral shields are not justified at any price and stationary lateral shields are not justified at a plutonium price below \$25 per gram. At a plutonium price of \$30 per gram, the optimum width of a stationary lateral shield should be 0.35 m. With regard to the use of secondary fuel in fast reactors, there are two stages in nuclear power expansion: power equipment construction and fuel production are the limiting factors in the first stage, fuel performance in the reactor is the limiting factor in the second stage. Figure 1, references 3 Russian.

[119-2415]

SYSTEMS ANALYSIS METHOD FOR IMPROVING FAST REACTORS

Minsk IZVESTIYA AKADEMII NAUK BSSR: SERIYA FIZIKO-ENERGETICHESKIKH NAUK
in Russian No 4, Oct-Dec 81 (manuscript received 12 Mar 81) pp 18-23

ILYUNIN, V. G., KAGRAMANYAN, V. S., MUROGOV, V. M., TROYANOV, M. F. and
SHMELEV, A. N., Institute of Physics and Power Engineering, Obninsk; Moscow
Physico-Technical Institute

[Abstract] A method of calculation is proposed for evaluating various means of improving a fast reactor from the standpoint of overall system economy. It is based on the equation of fuel balance in a binary model that corresponds to the present stage of nuclear power development, on the equation of energy production growth and on an exponential trend of further nuclear power development. In the analysis a fast reactor is considered operating in parallel with a thermal reactor. Calculations made for the former with either oxide or metal fuel and the latter either a water-moderated water-cooled power type or high-temperature gas type reveal that improvements of a fast reactor in an atomic electric power plant will become more effective as the thermal reactor is also improved. The criterion functional is defined so that, with three governing cost factors known, the effect of varying any of three essential parameters can be evaluated. Tables 3, references 3: 2 Russian, 1 Western.
[119-2415]

UDC 621.311.25:621.039:697.34

SYSTEMS APPROACH TO OPTIMIZING FAST REACTOR PARAMETERS

Minsk IZVESTIYA AKADEMII NAUK BSSR: SERIYA FIZIKO-ENERGETICHESKIKH NAUK
in Russian No 4, Oct-Dec 81 (manuscript received 14 Nov 80) pp 11-17

BRAILOV, V. P. and CHAKHOVSKIY, V. M., Institute of Power Engineering
imeni G. M. Krzhizhanovskiy

[Abstract] The problem of optimizing the parameters of fast reactors from the standpoint of economy has been studied by the system approach. A cost analysis based on hundreds of computer simulations has yielded criterial relations which account for cost components in the entire atomic electric power plant rather than only local cost components involving the reactor alone. The target function is defined accordingly and the algorithm of overall cost minimization is constructed on this basis. One important result of such optimization is a less severe steam power cycle, requiring typically only 130-140 kgf/cm² pressure and 490-510°C superheat in a 1500 MW plant with steam and sodium cycles. Table 1, references 3 Russian.
[119-2415]

INTERRELATION BETWEEN INITIAL AND STEADY STATES OF FAST REACTOR WITH
 N_2O_4 COOLANT DURING REFUELING

Minsk IZVESTIYA AKADEMII NAUK BSSR: SERIYA FIZIKO-ENERGETICHESKIKH NAUK
in Russian No 4, Oct-Dec 81 (manuscript received 12 Mar 81) pp 5-10

STAVROV, A. I., Institute of Nuclear Power Engineering, BSSR Academy of Sciences

[Abstract] The behavior of fast reactors after burnup and refueling, with attendant transition from the initial state to the steady state, is analyzed from the standpoint of desirable performance optimization. Calculations of the thermal field, heat evolution within low-enrichment and high-enrichment zones of the core are based on a 1500 MW el. reactor with N_2O_4 coolant and four different refueling schemes. These schemes are one-shot, zonal-partial, and two variants of transposition of fuel cassettes. The reactor characteristics are found to change during the transient period, in a manner which depends on the refueling scheme and on the interval between refueling events. Accordingly, the refueling scheme for a given reactor must be selected taking also into account the initial state and with consideration of the optimum transient behavior.

Figure 1, table 1, references 4 Russian.

[119-2415]

NON-NUCLEAR ENERGY

SOVIET SCIENTIST SEES VIBRATION RESONANCE AS SOURCE OF FUTURE TECHNOLOGY

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 12 Nov 81 p 4

[Article by Ye. Yakovich: "An Era of Quantum Machines?: A Claim for the Future"]

[Text] "In principle, it is possible to make railroad cars move without a locomotive -- mechanical energy will be delivered to their wheels by the rails themselves. Or, to create a motor vehicle with a flywheel storage cell which, with one unloading, will be able to run 1500 to 1700 kilometers . . . "

As if having sensed our disbelief in this forecast, the director of the Donetsk Branch of the Scientific-Research Mining Institute and candidate of engineering sciences, N. Garmash, hastened to add here:

"Of course, these will be special machines and mechanisms. In any case, the conditions of their operation will have to be calculated with the assistance of the mathematical equipment of quantum mechanics . . . "

"Quantum mechanics? But its laws are applicable only to phenomena of the micro-world -- at the level of atoms and molecules. But here we are talking of mechanisms of many tons . . . "

"We also thought that way until we found out otherwise. In fact, it all began with an ordinary belt conveyor for transporting dirt at open pits . . . "

"Created in a laboratory, this conveyor was a surprise under testing. As the belt speed reached a certain amount, the machine began to shiver as with a fever. The verdict of the specialists was simple: the cause of it all was resonance between the belt and the supports. How could this be avoided? All of the measures that the developers could think up either complicated the design or required additional expenditures of energy.

"The most vexing thing," recalls Nikolay Zakharovich, "was that these tests revealed a tempting detail: resonance practically . . . eliminated friction. If, while doing this, it didn't eliminate the machine itself right away!"

To tell the truth, what was "vexing" to the scientist was not very clear to us. Of course, in the cold language of scientific formulas, resonance is "the response of material systems to external perturbation." But we know that this "response" most

often is destructive. A bridge that collapses under a column of soldiers marching in step, a glass that breaks from the sound of a violin at a distance, or turbines that go haywire at a certain number of revolutions -- a large number of such examples could be introduced.

"And meanwhile," continues N. Garmash, "they indicate that our memory is selective. Take, for example, oscillatory circuits in radios, electronic resonators, vibrating screens, or vibration pile drivers -- here, resonance "works" as a creative force. If it weren't for resonance, many musical instruments would not exist. Thus, our attempt to use the positive character of resonance does not look so foolish. Another thing is that classical mechanics often does not provide the answer as to how to control this phenomenon . . . "

"Is this why you have decided to turn to the methods of quantum mechanics?"

"To some degree, this way was prompted for us by the ill-fated conveyor: it obviously behaved 'strangely' -- the speed of the belt, the amount of movement, the energy used under resonance conditions changed by fits and starts and by portions. An analogy with quanta inevitably arose. And we decided to take a risk . . . "

Calculations made with the help of quantum mechanics methods led to surprising results. This same belt conveyor, when the resonance effect was used on it, increased many times its speed and coefficient of useful operation. But still more tempting were the prospects that were being opened up for theoretical and experimental research by scientists.

"For the time being, this research indicates that, having 'taught' machines to work steadily under the sometimes dangerous conditions of resonance, they can be improved considerably. Let us assume that we are able to improve productivity by a factor of tens(!) in rotary excavators and drilling equipment. Other machines -- we will call them quantum machines -- can reach a coefficient of useful operation of up to 100 percent. And simultaneously, they can be made more rapid, more reliable, and more durable . . . "

"Almost like a perpetual motion machine . . . "

"No, we haven't successfully invented a perpetual motion machine: to develop machines to operate under resonance conditions and then maintain those conditions, some kind of energy must be supplied. Another thing is that, judging by calculations, much less of it is required. And it is expended almost without loss. Let us say that, in the conveyor, the transmission of movement from drum to belt will be accomplished not by friction, but through the exchange of quanta of energy. In this way, the working speeds, productivity, and length of service of conveyors can be increased by a factor of 8 to 10, and the use of energy can be decreased to a half or a third of what it was . . . "

"And how do you hope to make a railroad car move without a locomotive?"

"For this, there has to be a traveling wave sent along the rails that "feeds" energy to the rotating wheels. And a quantum storage cell for a motor vehicle, while discharging, should store a large part of the energy in the form of elastic deformation of the flywheel . . . "

"Frankly speaking, all this is difficult to imagine."

"Not only for you, but also for many specialists. When, in 1940, in Washington State, there was a collapse of the Takoma Canal Bridge, which had been designed according to the strict rules of engineering science, there was considerable bewilderment. The reason for the catastrophe -- the wind -- was distinguished neither by special force nor by violence. Nevertheless, the vibrations caused by this wind, coinciding with the structure's own vibrations, acquired destructive power. Figuratively speaking, it was as if the resonance took in its hands all the energy spread over a large mass of air. And now, imagine that we have begun, with the aid of resonance, to accumulate such energy in machines and mechanisms -- of course, not carrying it up to destruction. On this basis, it will be possible to create mechanical quantum generators, accumulators of mechanical energy, transformers, and amplifiers."

"And all this through the methods of quantum mechanics?"

"First the designers must have their chance to earn their keep; the creation of quantum machines also requires conceptually new solutions from them. The calculation methods, however good they are, remain only a tool for analysis, a compass that shows the way to investigate. Moreover, we still do not know how widely applicable the quantum approach is. It is not exceptional in that it forces the reexamination of many views not only in engineering, but in other fields . . . "

"In which ones for example?"

"One such field is biology. Let us say that scientists up to now have argued about why a dolphin, on a 400-kilometer 'run,' uses only 100 grams of fat. But if one assumes that, between its subcutaneous blood vessels and the waves flowing along its body, there is a resonance bond, then the high degree of economy becomes understandable. Certainly, other biological subjects also use resonance to avoid unnecessary expenditures of energy. It is worth thinking about this: is it possible that this may be the very reason that our heart doesn't 'get tired' pushing such a large amount of blood? . . . "

The scientists don't like to overrate their work. But they have applied the methods of quantum mechanics to the world of big technology. The unusual conveyor is already operating, and calculations have been made for many other mechanisms. But this is only the beginning: at present they are only learning to control a formidable phenomenon, trying to transform resonance into a creative force. It is dangerous to be in too much of a hurry in making forecasts. But, is it perhaps possible that these investigations will start a new era of quantum machines?

9645

CSO: 1861/94

INDUSTRIAL TECHNOLOGY

UDC 62-501.72:681.325...2

CONTROL ALGORITHMS FOR SENSITIZED MANIPULATOR

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian
No 10, Oct 81 (manuscript received 27 Jun 80) pp 130-132

ZHABOTINSKAYA, T. N., graduate student, and MOZHZHEVELOV, S. B., engineer

[Abstract] The possibility of using a properly sensitized manipulator for surface treatment of product parts is considered and two computer control algorithms are proposed to make this feasible. One algorithm involves minimization of the difference between the vertical component of strain gauge readings along a sloping surface and the given pressing force on the tool, a zero difference corresponding to a smooth horizontal surface. This algorithm has been programmed in FORTRAN-4. The other algorithm involves preliminary testing of the force on the tool relative to the threshold that corresponds to separation from the surface, and a subsequent search for contact between tool and surface along a circle or a spiral. This is followed by a check of the surface for sloping or flatness. Control signals are generated so as to ensure that the tool velocity remains always tangent to the surface. Both algorithms have been tested experimentally on a NOVA-2/10 computer for control of an ADAM-1 adaptive manipulator holding a 3-component force transducer with a finishing tool at the tip. Figures 3, references 2 Russian.
[100-2415]

UDC 531.8

LAYOUT AND DESIGN OF DEVICE FOR FORCED FIT SETTING IN DIFFERENTIAL TRANSMISSIONS OF MANIPULATORS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian
No 10, Oct 81 (manuscript received 3 Jun 81) pp 45-49

OVAKIMOV, A. G., doctor of technical sciences, professor

[Abstract] Differential gear or cable transmissions are used in manipulators for ensuring independent operation of all kinematic pairs driven by motors mounted

on one stationary link. Here a simple device with a single torsion bar is described that constitutes an additional transmission channel ensuring necessary clearances and forces required to maintain them. It is designed to satisfy conditions of balance of torques at both input shafts of one differential and the condition of equal angular displacements of both shafts. The performance of this device is analyzed on the basis of the equilibrium condition for the manipulator and the corresponding principle of possible displacements. Its application is demonstrated on a problem of adjustment for given internal torques and a problem of ensuring finite internal torques in a manipulator with minimum number of differentials in the additional drive channel. Figures 2, references 3 Russian.
[100-2415]

UDC 007.52

SOME PROBLEMS IN COMPUTER-AIDED INDUSTRIAL ROBOT DESIGN

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian
No 10, Oct 81 (manuscript received 14 Apr 80) pp 41-45

SIBRIN, A. P., candidate of technical sciences, docent, and OATUL, O. A.,
graduate student

[Abstract] An industrial robot is considered for manufacturing processes which utilize the electrohydraulic effect, specifically for rolling out tubular holes in face plates of heat exchangers. The application problem is to ensure higher productivity combined with better metal economy and more reliable gas-tightness of joints than attainable with manual labor. Especially critical operations are inserting cartridges with explosive into the plate holes and connecting electrodes for subsequent detonation. The design problem is to combine excellent dynamic characteristics of the servomechanism with physical feasibility and maximum simplicity of the control system. A general structure of such an industrial robot has been laid out in accordance with these requirements and four possible variants of the kinematic linkage have been analyzed. These are rotary-rotary, rotary-translatory, translatory-rotary, and translatory-translatory kinematic pairs. Performance and design calculations, based on Lagrange equations of the second kind in vector-matrix form with a four-dimensional state vector, have been programmed in FORTRAN-4 for a Unifoed System computer. The universal program includes numerical integration of right-hand sides of differential equations by the Runge-Kutta method, graph plotting, calculation of control actions, and evaluation of the Jacobi matrix along the reference trajectory for stability analysis. The system is assumed to be initially in a state of static equilibrium, and input variables are adjusted accordingly. Figures 3, references 3 Russian.
[100-2415]

VALVE DESIGN FOR MAXIMUM FLOW RATE

Moscow TEPLOENERGETIKA in Russian No 12, Dec 81 pp 63-65

SEREGIN, V. A., engineer (dissertator), ZARYANKIN, A. Ye., doctor of technical sciences, and GOLOVINA, L. G., candidate of technical sciences, Moscow Power Engineering Institute

[Abstract] A steam distributing valve for a large turbine set is designed from the standpoint of maximizing flowrate and minimizing pressure drop in any position up to fully open. Such performance is attained with smooth profile of the converging-diverging channel which will ensure stable flow without pressure fluctuations and valve vibrations. The problem reduces to transforming the appropriate second-degree differential equation for the flow function to a quadratic trigonometric equation and solving the latter for the surface profile generatrix. A valve has been designed according to this procedure, then built and tested, its performance characteristics found to be superior to those of a conventionally designed and built one. Figures 6, references 5 Russian. [112-2415]

UDC 621.9.06:658.2./ 62-5

INTRODUCTION OF MACHINE TOOLS WITH PROGRAMMED DIGITAL CONTROL IN HEAVY MACHINERY MANUFACTURING INDUSTRY

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 12, Dec 81 pp 21-23

LOVILIN, M. Ya., chief technologist, Management of Technology and Metallurgy

[Abstract] Machine tools with programmed digital control are operating in many heavy and transportation machinery manufacturing plants, the largest number in the "Uralsmash" plant. In 1980 their total number industry-wide was 1320 (184 in the "Uralsmash" plant alone, 34 in the Novokramatorskiy plant, and only 2 in the Uzlovskiy plant). They yield the largest economic effect when used for processing of intricate machine parts with high labor input operating in a closed cycle, and when installed in a separate single workshop within a particular factory. One major impediment to their more extensive and effective use is inadequate matching to specific applications due largely to imprecision of customers' orders. Experience gained so far has been very helpful in establishing the optimum requirements and operating conditions for such machine tools. Data are available on their capabilities and the resulting production costs as well as on loading cycles and work shift scheduling. Activities at the laboratory of the Scientific Research and Design Technological Institute of Machine Manufacturing include development of special-purpose cutters adaptable to such machine tools, simplification and supplementation of the equipment, training of skilled

personnel, implementing more effective use of computers such as the Minsk-32, and further automation of the machine tool operation. Metal machining equipment with programmed digital control is expected to operate at a load factor up to 0.95 and shift system of at least 1.7 by the year 1985.
[133-2415]

UDC Δ62-229.7:621.74

OUTLOOK FOR INTRODUCING AUTOMATIC MANIPULATORS IN HEAVY MACHINERY MANUFACTURING INDUSTRY

Moscow MEKHAIZATSIIYA I AVTOMATIZATSIIYA PROIZVODSTVA in Russian No 12, Dec 81 pp 19-21

ABRAMYAN, E. S., chief engineer, All-Union Industrial Association
"Soyuztyazhmashtekhnologiya"

[Abstract] Several branches of the heavy machinery manufacturing industry are engaged in introducing and adapting automatic manipulators to various phases of the production process, most significant being the efforts of the Kramatorskiy Scientific Research and Design Technological Institute of Machine Manufacturing. The automatic manipulators, series manufactured or custom built, include MK-2 and MAG-1 as well as "Tsiklon 3B", "Brig-10", "Universal 15M". The major achievements so far are sheet stamping lines drop forging lines, welding lines, and lathes run by automatic manipulators with programmed control, usually digital. Such items as slotted bolts and brake shoes for railroad rolling stock are already produced in this manner. Installation of these lines requires organizational planning and technological compatibility, it also must yield economic effect and has done so in several heavy machinery manufacturing plants (Yuzhno-Uralskiy, "Slavtyazhmash", Kaluzhskiy, Novokramatorskiy, Zhdanskiy). Figures 2.
[133-2415]

STRAIGHTENING BENT TURBINE RUNNER SHAFTS BY REGULATED THERMAL SHOCK METHOD

Moscow ENERGETIK in Russian No 11, Nov 81 pp 31-32

MIKHAYLICHENKO, V. S., engineer

[Abstract] Shafts of steam turbines may bend excessively in service, due to imbalance and vibration. They are made of pearlitic carbon steel, whose mechanical and temperature characteristics limit the effectiveness of shaft straightening during overhaul by conventional "relaxation" or "creep" methods. The practical "factory" method, on the other hand is too labor and time consuming. Treatment by regulated thermal shocks in an aluminum melt and by mechanical vibration at regulated resonance frequency, to avoid "recovery" of

the deflection, are found to be most effective and economical. The thermal shock process has been developed by the Rostov Administration for Repair of Electrical Power Equipment, the vibration process is patented in several western countries (United States, United Kingdom, France, West Germany, Japan). During the 1974-79 period these processes were successfully applied to 28 turbine runners of 18-800 MW with shaft deflections ranging from 0.20 to 1.30 mm. At least 2.9 million rubles were saved by this operation.
[104-2415]

ROBOTS TODAY AND TOMORROW

Moscow AGITATOR in Russian No 17, Sep 81 pp 30-31

ZAGURA, I.

[Abstract] The LIP-2 experimental robot which has been built by scientists at the Leningrad Polytechnic Institute (Special Design Office of Engineering Cybernetics) is on display at the Exhibition of Achievements of the USSR National Economy. Its hand with two "fingers" operates with 12 ultrasonic sensors, its "eye" is a television camera and its "brain" is a computer. Although this is the most advanced modern robot, it can still perform only very simple tasks. There are not altogether approximately 7,000 robots (automatic manipulators) installed in Soviet industry, relieving 20,000 workers of heavy manual labor. In the 11th Five-Year-Plan period their number should increase to 45,000 industrial robots relieving up to 120,000 workers. The history of the LPI-2 robot can be traced to the "Elektrosila" plant in Leningrad, where its first-generation prototype was developed for feeding ingots to a molding press and thus taking over a most tedious and dangerous job. Nonsensitized grip mechanisms were subsequently replaced with sensitized ones in the second-generation prototype. Although man at the assembly line is characterized as working like an automaton, according to professor M. B. Ignat'yev (chairman, Leningrad Institute of Aviation Instruments), an automaton still cannot match man's alertness and response to unexpected situations. It will thus be necessary to make the robot capable of processing a full scope of information about the outside world, to recognize position and color as well as shape and size of objects. The third-generation robot, an autonomous "adaptive roboto-technical system", should be able to completely replace man at the assembly line. Guidelines for more extensive development and application of industrial robots, with microcomputer-aided programmable automatic control, have been set forth at the 26th CPSU Congress.
[124-2415]

MACHINING ACCURACY ON LATHES WITH NUMERICAL PRESET CONTROL

Moscow STANKI I INSTRUMENT in Russian No 10, Oct 81 pp 3-5

MAKAROV, N. V. and GORYUNOV, I. P.

[Abstract] Work experience and laboratory studies have shown that the machining accuracy of lathes with programmed control is determined by the following errors: error X_1 of positioning of the saddle carriage (longitudinal or transverse); error X_2 of positioning of the cutter head or tool block when the tool is changed, as measured on the length of cutter overhand; error X_3 resulting from the cutting process, deformation of the SPID measurement system and other factors. The resultant machining error is

$$Y = \sum_{i=1}^3 X_i. \text{ Each error}$$

component is determined from the formula $X_i = x_i + \gamma_i K$, where the x_i are the instantaneous random deviations, K is the number of the workpiece in the batch being machined, and γ_i is the regression coefficient that accounts for systematic errors due to cutter wear, thermal deformations and other factors. The rms deviation is determined from the formula

$$\sigma^2 = 2 \sum_{i=1}^3 \sigma_i^2, \text{ where } \sigma_i \text{ is the rms}$$

deviation of x_i . The overall scatter of dimensions is $\Delta = 6\sigma + \gamma N$, where

$\gamma = \sum_{i=1}^3 \gamma_i$ is the regression coefficient of the dimensions, and N is the number

of parts in a batch. Predetermined precision is attained when $\Delta < \delta$ (here δ is the field of tolerance). The authors describe a method of determining requirements for discreteness and error of lathe components on the design stage. It is shown that the field of scatter of elementary errors of the lathe at discreteness of 1 μm must not exceed 3.3 μm for workpiece diameters of 75-630 mm (field of tolerance 20 μm). Recommendations are made on improving positioning accuracy of the saddle and tool block. Figures 2, references 2 Russian.

[97-6610]

SPEED OF ADAPTIVE MILLER CONTROL SYSTEM

Moscow STANKI I INSTRUMENT in Russian No 10, Oct 81 pp 5-6

IL'IN, O. P., PRIMSHITS, P. P. and ROGOV, A. M.

[Abstract] An examination is made of factors that influence the speed of action of an adaptive system for controlling a milling machine with consideration of wobbling of the cutting tool due to asymmetric sharpening or off-axis alignment. An analysis is made of productivity factors that warrant use of a high-speed adaptive control system, and limits of applicability of such systems are determined. It is shown that in designing the adaptive system it is necessary to maximize the speed of the channel that stabilizes the cutting moment. Oscillograms are given that confirm the calculations. Figures 3, references 3 Russian. [97-6610]

ESTIMATION OF CARRYING CAPACITY OF CAST TURBINE RUNNERS FROM EQUIVALENT
ACCELERATION TESTS

Kiev TEПЛОВЫЕ НАПРЯЖЕНИЯ В ЭЛЕМЕНТАХ КОНСТРУКЦИЙ in Russian No 20, 1980
(manuscript received 18 Jul 78) pp 106-110

GREBELYUK, Ye. M., KARPIKOV, G. V., GORYNIN, L. G. and ROGOVA, Ye. V.,
Siberian Automobile and Highway Institute

[Abstract] A procedure has been developed for estimating the load capacity of cast turbine runners on the basis of equivalent acceleration tests on model disks. The test stand includes a compressor with drive, combustion chamber and acceleration chamber. The gas parameters, namely temperature and pressure as well as flow rate, are determined from the particular runner performance requirements and preset accordingly. Calculations are based on the critical speed at which fracture will occur in either a meridional section or cylindrical section first. A special method of temperature measurements, developed together with V. A. Nikolayenko from the Institute of Atomic Energy imeni I. V. Kuratov, utilizes irradiated materials such as diamond and silicon carbide as indicators of steady temperatures from 130 to 1200°C within $\pm 5^\circ\text{C}$. On the basis of such tests can, subsequently, the prototype turbine wheel can be optimally designed for the necessary safety margin with respect to thermal stresses. Figures 4, references 5 Russian.

[111-2415]

STATE OF THERMAL STRESS IN RADIAL TURBINE STAGE RUNNER

Kiev TEPLOVYYE NAPRYAZHENIYA V ELEMENTAKH KONSTRUKTSIY in Russian No 20, 1980 (manuscript received 14 Nov 78) pp 103-106

SAVCHENKO, V. I., MYL'NIKOV, A. V., GREBELYUK, Ye. M. and USHERENKO, L. Ya., Kiev University

[Abstract] A model study was made to determine the state of thermal stress in the disk of a radial ZhS-3DK gas-turbine stage, this being the most critical component exposed to high gas temperatures during operation. Measurements by the photothermoelasticity method were made on three 1:1.5 scaled-down models: disk without blades with center hole, disk without blades with center hub, disk with blades and center hole. The reference was a prototype of such a turbine wheel in which the temperature field under transient conditions had been determined with diamond probes and thermocouples. The pattern of thermal stresses, including cracking and fracture, was established on the basis of subsequent calculations with the aid of dimensional analysis. Thermal stresses were found to be of the same order of magnitude in all three disks, circumferential stresses being higher than radial and axial ones and reaching their highest level at half-way across the disk thickness. The effect of blading on thermal stresses at the center was found to be insignificant. Figures 4, table 1, reference 1 Russian. [111-2415]

UDC 621.175.621.016.4

COEFFICIENT OF HEAT TRANSFER IN CONDENSERS OF STEAM TURBINES

Moscow TEPLOENERGETIKA in Russian No 12, Dec 81 pp 59-61

BRODOV, Yu. M., candidate of technical sciences, SAVEL'YEV, R. Z., candidate of technical sciences, and NIRENSHTEYN, M. A., engineer, Ural Polytechnic Institute

[Abstract] Several formulas for the coefficient of heat transfer in steam condensers are compared and their accuracy is checked against experimental data. They include the Institute of Heat Transfer (USA) formula $k = k_{01} b_M \beta_{ti}$, the BEAMA (USA or UK) formula $k = k_{01} a b_M \beta_{tm}$, P. A. Roubinet's formula $k = 5800 w^x (k_{01} - \text{heat transfer coefficient at water inlet temperature of } 21^\circ\text{C, } a - \text{correction factor accounting for contamination of condenser tubes, } b_M - \text{correction factor accounting for material and thickness of condenser tubes, } \beta_{ti} - \text{correction factor for actual water inlet temperature, } \beta_{tm} - \text{correction factor for mean temperature of cooling water, } w - \text{velocity of water in condenser tubes, } x - \text{fractional factor and power exponent characterizing the condenser surface condition}), \text{ and a few modified formulas by Soviet authors. Test data}$

have been compiled on 100KTsS-4, 200KTsS-2, 300KTsS-1 condensers manufactured at the Leningrad Metal Plant, K-100-3685 and K-15,240 condensers manufactured at the Khar'kov Turbine Plant, and KG-26,200 condensers manufactured at the Tomsk Metal Plant. The first two formulas are found to be most accurate for condensers operating under nominal conditions, all formulas except Roubinet's are found to be satisfactory for condensers operating below rated levels. This latter formula as well as the one according to the Institute of Heat transfer do most accurately account for effect of the inlet water temperature. The largest source of error in most formulas is their inaccurate accounting for the effect of the steam flow rate. Figures 4; references 9: 6 Russian, 3 Western.
[112-2415]

UDC 539.621.81

CARRYING CAPACITY OF ACTIVE COMPRESSOR RUNNERS FOR AIRCRAFT GAS-TURBINE ENGINES UNDER SHORT CYCLIC LOAD AT NORMAL OR HIGHER TEMPERATURES

Kiev PROBLEMY PROCHNOSTI in Russian No 11, Nov 81 (manuscript received 6 Nov 80) pp 45-48

BAZHENOV, V. G., BALYUK, A. D., REZNIK, B. G. and GONTAROVSKIY, V. P.,
Zhitomir branch, Kiev Polytechnic Institute

[Abstract] A set of hermetic chambers has been built for determining the strength of compressor runners for aircraft gas-turbine engines at room temperature (20°C) and at higher temperatures (230°C). They are designed for short (60 s) cyclic load tests with deep levels of rarefaction and over a wide range of speeds. The stress distribution in model runners for these simulation tests were calculated by the finite element method according to the theory of small elastoplastic strains, taking into account centrifugal forces as well as nonuniformity of temperature field and temperature dependence of material properties, also the effect of interaction with runners in adjacent compressor stages. Tests performed in these chambers have revealed the pattern of fatigue cracking and fracture at certain speeds above nominal. Figures 3, references 3 Russian.
[117-2415]

TECHNOLOGY OF REDUCTION OF ENLARGED RADIAL CLEARANCES IN TURBINE SEALS

Moscow ENERGETIK in Russian No 11, Nov 81 pp 6-7

RABINOVICH, Ye. A., engineer, LEVSHIN, B. I., engineer, and TSELYUBA, S. A., engineer, Central Design Office, Main Administration for Repair of Electrical Power Equipment, Khar'kov branch

[Abstract] A new technology has been developed for restoration of small radial clearances in turbine seals after wear of cylinders due to heating and vibration in service. A reduction of radial clearances to their nominal size is necessary, since a 50-100% enlargement has been found to lower the economy of turbine operation by as much as 1%. The process involves precise gaging of the clearances, assembly of the seal segments in a special fixture, and turning the entire seal ring on a lathe. The method is much less labor and time consuming than conventional trimming of seal rings directly on the turbine runner during overhaul. It is most expedient to turn the seals before the runner is centered back in the turbine and thus avoid subsequent trimming. Figures 2.

[104-2415]

UDC 539.4:624.074

CALCULATING LOAD-BEARING FRAMES OF GAS TURBINE ENGINES: REPORT 1

Kiev PROBLEMY PROCHNOSTI in Russian No 8, Aug 81 (manuscript received 12 May 80) pp 39-44

ZHUKOV, V. B. and KOLESNIKOV, V. I., Zaporozh'ye

[Abstract] The load-bearing frames are made up of concentric circular rings interconnected by struts and reinforced by thin shells of the gas turbine engine stator at points of attachment of the engine to the aircraft. These frames are loaded by radial, tangential and axial forces and torques that arise at engine suspension points. The frame components are also subjected to gas pressure and temperature stresses due to engine operation. Conventional methods of strength calculation for such systems are applicable to frames with a small number of struts, as they are based only on bending strains, and do not account for tension and shear of the cross sections of the load-bearing rings. The author propose a method of calculation that takes consideration of tensile and shear strains, which have a considerable effect on the stressed state under complex local loading conditions. The analysis also covers combined operation of load-bearing frames and shells, the mutual influence of ring stiffnesses in and out of the plane, and also warping of cross sections made in the form of open thin-walled structural elements. It is assumed that the rings have small curvature, and one of the principal axes of the cross section lies in their plane. The shells are treated as orthotropic, untorqued and thin-walled, the middle surface coinciding with the neutral line of the rings. Differential equations are derived for rings, shells and struts. Figures 4, references 6 Russian.

[95-6610]

CALCULATING LOAD-BEARING FRAMES OF GAS TURBINE ENGINES: REPORT 2

Kiev PROBLEMY PROCHNOSTI in Russian No 8, Aug 81
(manuscript received 12 May 80) pp 45-48

ZHUKOV, V. B. and KOLESNIKOV, V. I., Zaporozh'ye

[Abstract] Relations derived in a preceding article [PROBLEMY PROCHNOSTI, No 8, Aug 81, pp 39-44] are applied to solution of the problem of the stressed and strained state of load-bearing frames of gas-turbine engines under complex local loading conditions. The analysis covers cyclic loading that produces symmetric and skew-symmetric strain relative to the vertical diameter of the frame rings, and axially symmetric loading of the frame. The resultant relations are used to calculate the stressed and strained state of a ring system reinforced by an isotropic semi-infinite shell as a function of temperature, internal pressure and axial forces. It is found that accounting for tensile strain reduces stresses in the struts by a factor of five, and accounting for shear strain lowers them by 20%. It is concluded that deformations due to shear, tension and warping of cross sections of the frame rings have a considerable effect on strength calculations, and should be taken into consideration in designing the load-bearing frames of gas turbine engines. Figure 1, reference 1 Russian.
[95-6610]

UDC 539.432+620.178.3+620.194.8+620.197.5+621.438+621.515

COMPARATIVE ANALYSIS OF GAS TURBINE ENGINE COMPRESSOR BLADE DURABILITY

Kiev PROBLEMY PROCHNOSTI in Russian No 8, Aug 81
(manuscript received 29 Apr 80) pp 105-110

TORGOV, V. N., Kiev, Institute of Strength Problems, UkSSR Academy of Sciences

[Abstract] A comparative analysis is done on the compressor blades of a marine gas turbine engine for different grades of steel: 20Kh13, Kh17N2, 1Kh12N2VMF and A. The object of study was the inlet guide vane of the compressor. The analysis is based on experimental data for the rate of crack growth as a function of the coefficient of stress intensity $K_I = \sigma_a Y(c) \sqrt{c}$, where σ_a is the amplitude of alternating bending stresses at a characteristic point of the blade cross section, c is the length of the crack and $Y(c)$ is the geometric factor. It is found that the durability of blades when tested in brine increases slightly, while crack propagation stresses decrease by a factor of about 1.4. Magnesium protector shielding increases blade durability by a factor of 1.5, and threshold stresses $\sigma_{th} = K_{th} / Y(c) \sqrt{c}$ (where K_{th} is the threshold value of K_I) reach values

equal to those obtained with testing in air. Least durable are blades of 1Kh12N2VMF steel. The most dangerous cracks are those propagating from the leading and trailing edges of the blade, and least dangerous are those propagating from the back of the blade. Figures 5, tables 2, references 6:

4 Russian, 2 Western.

[95-6610]

APPLICATION OF MATRIX CALCULUS TO SPACE FLIGHT DYNAMICS PROBLEM

Kiev PRIKLADNAYA MEKhanika in Russian Vol 17, No 12, Dec 81
(manuscript received 29 May 79) pp 89-96

GUBENKO, V. S. and KRAVETS, V. V., Dnepropetrovsk Institute of Railway
Transportation

[Abstract] An axisymmetric body consisting of two modules (carrier and payload) is considered in free space flight with large linear and angular displacements. The reactions and internal dynamic loads in the plane of contact are calculated by solving the Euler-Lagrange differential equations of motion in matrix form, with the use of Euler-Krylov angles and with the aid of appropriate transformations. The resultant matrix equation can be resolved into two matrix equations, one for each module. The one describing the dynamics of the carrier is simpler to solve, the other will serve to verify the calculations. The algorithms of numerical solution are programmable on a digital computer. Figure 1, references 9 Russian.
[113-2415]

UDC 681.513.6

LOCAL STRAINS IN CONTINUOUS-SURFACE MIRRORS AND THEIR FREQUENCY DEPENDENCE

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 11, Nov 81
(manuscript received 13 Nov 80) pp 11-13

TARANENKO, V. G., KOSHELEV, G. P. and ROMANYUK, N. S.

[Abstract] Active mirrors with controllable surface profile are used as adaptive components in astronomical instruments for dynamic correction of random phase distortions in the wave field. An experimental study was made to determine the dependence of strain amplitude in such mirrors of continuous-surface type on control voltage applied to the piezoelectric shaping drive. With a piezoelectric forming disk 20 mm in diameter, this dependence on the voltage level was found to be linear up to 200 V. The strain amplitude was also found to decrease linearly with increasing mirror stiffness-to-thickness ratio. The radial response profile from the center of the forming drive was found to fit, within 5%, a gaussian function $e^{-r^2/A}$ for soft mirror materials such as copper ($A = 191$ for 3 mm thick mirror) or aluminum ($A = 304$ for 9 mm thick mirror) and a hypergaussian function $e^{-r^{2.5}/A}$ for hard mirror materials such as steel ($A = 1464$ for 3 mm thick mirror). The frequency response of such mirrors was found to be flat up to 1 kHz and with resonance peaks above 10 kHz, at frequencies depending on the mirror stiffness and thickness. Figures 4, references 3: 2 Russian, 1 Western.

[132-2415]

UDC 532.528

CONE DRAG IN CAVITATION FLOW

Kiev GIDROMEKHANIKA in Russian No 44, 1981 (manuscript received 3 Dec 79)
pp 94-96

PUTILIN, S. I., Institute of Hydromechanics, UkSSR Academy of Sciences

[Abstract] Experiments were done to determine cavitation drag on cones with vertex angles ranging from 50° up to 180° (disk). Cavitation was produced by a special device that pumped air to the base of the model. The Froude number $Fr = V/\sqrt{gd}$ ranged from 46 for the sharpest cone to 82 for the disk in a small hydrodynamic tunnel, with corresponding values from 23 for the sharpest cone to 41 for the disk in a tunnel with eight times the cross sectional area of the small tunnel. The corresponding Reynolds number ranges were $6 \cdot 10^4 - 1.9 \cdot 10^5$ and $3 \cdot 10^4 - 10^5$. The measurement results are given as plots of drag C_x versus cavitation number σ . These plots are close to linear for cavitation numbers from 0 to 0.2, conforming to the law $C_x(\sigma) = C_{x0}(1 + \sigma)$, where C_{x0} is the drag at $\sigma = 0$. The curve for C_{x0} as a function of cone angle agrees with data in the literature. The tests in large and small hydrodynamic tunnels showed that the dimensions of the flow have a considerable effect on the minimum attainable cavitation number. Figures 3, references 6 Russian.

[96-6610]

UDC 532

HYDRODYNAMIC DRAG OF PLATES AND SHELLS

Kiev GIDROMEKHANIKA in Russian No 44, 1981 (manuscript received 7 Jul 79)
pp 96-100

TEMNENKO, V. A., Simferopol' State University

[Abstract] The conventional methods used to solve problems of determining hydrodynamic drag of simple solids such as plates and disks lead to nonlinear

or unsteady equations involving complicated calculations. The author proposes a semiempirical method that results in a linear problem. The proposed approach involves three assumptions: 1. the pressure distribution on the surface facing the flow is taken as the same as that for potential flow of an ideal incompressible fluid past the "effective" surface; 2. the base pressure is taken as constant along the outer surface; 3. the pressure differential on the edge of the surface is taken as zero. The "effective" surface is increased somewhat with respect to the actual surface. For example when determining the pressure on the forward surface of a disk of radius r , the proposed approach uses the solution of the potential flow problem for a disk of radius Sr , where $S > 1$. S can be expressed in terms of the base pressure p_B , or the dimensionless number $Q = (p_\infty - p_B)/q$, where p_∞ is the fluid pressure far from the surface in the flow, and q is velocity head. Determination of drag at given Q reduces to solution of the problem of potential flow past the surface, which in turn reduces to an integral equation that is solved by the conventional discrete vortex method. Equations are derived for drag of a disk, a flat plate and a spherical dome. Critical parameters are determined. References 14 Russian.

[96-6610]

UDC 539.377

THERMOELASTIC STRESSES IN CYLINDER OF MATERIAL WITH TEMPERATURE-DEPENDENT
PHYSICOMECHANICAL PROPERTIES

Kiev TEPOVYYE NAPRYAZHENIYA V ELEMENTAKH KONSTRUKTSIY in Russian No 20,
1980 (manuscript received 14 Jun 77) pp 57-63

GARANCHUK, V. A., POSTOL'NIK, Yu. S. and GUBA, V. M., Dneprodzerzhinsk
Industrial Institute

[Abstract] The thermoelasticity problem is solved in quasi-static form for a hollow infinitely long cylinder symmetrically heated from the outside at high intensity. Thermophysical and mechanical properties of the material are each represented as the product of a dimensional constant by a dimensionless function of temperature. The problem is solved first in displacements and then in stresses, by combining the method of equivalent sources with the method of a thermal layer. The results are extended to a solid cylinder of finite length convectively heated, specifically one made of Kh18N9T (18Cr-9Ni) steel at zero initial temperature. Figures 2, references 8 Russian.
[111-2415]

UDC 539.3

NONAXISYMMETRIC PROBLEM OF HEAT CONDUCTION FOR SHORT CYLINDER

Kiev TEPOVYYE NAPRYAZHENIYA V ELEMENTAKH KONSTRUKTSIY in Russian No 20,
1980 (manuscript received 19 Oct 78) pp 38-42

BABESHKO, M. Ye., Institute of Mechanics, UkSSR Academy of Sciences

[Abstract] The temperature field in a hollow cylinder of finite length under conditions of convective heat transfer to the ambient medium is calculated as a function of time during the transient period under asymmetric boundary conditions. The corresponding second-order differential equation is solved by the method of finite differences for temperature amplitudes after appropriate initial

conditions. The radial temperature distributions in a typical case at various instants of time during the heat-up period have been calculated with the aid of a computer. Figures 3, references 2 Russian.
[111-2415]

UDC 539.3

THERMOELASTIC BEHAVIOR OF PRISMATIC BODY UNDER SHORT ACTION OF NONUNIFORM HEAT SOURCES

Kiev TEПЛОВЫЕ НАПРЯЖЕНИЯ В ЭЛЕМЕНТАХ КОНСТРУКЦИЙ in Russian No 20, 1980 (manuscript received 20 Nov 78) pp 22-25

MOTOVILOVETS, I. A., NOVIKOVA, A. M. and SHEVCHENKO, S. I., Institute of Mechanics, UkSSR Academy of Sciences

[Abstract] The equation of heat conduction under conditions of convective heat transfer to an ambient medium at constant temperature is solved for a long free prismatic body of rectangular cross section with appropriate boundary and initial conditions. The state of stress and strain as well as components of the displacement vector are calculated from equations of state and Cauchy relations, assuming a plane temperature field in the prism and a symmetrically located heat source acting for a finite period of time only. The algorithm of this solution of the thermoelasticity problem has been programmed in ALGOL-60. Typical numerical results are shown for a heat pulse of relative duration $\tau_1 = \alpha t_1 / h^2 = 0.001$ (t_1 duration of heat source activity, h half-height of the prism, α thermal diffusivity of the prism material). Figures 2, references 3 Russian.
[111-2415]

UDC 539.3

THERMOELASTICITY IN MULTILAYER PLATES AND SHELLS WITH FINITE RIGIDITY

Kiev TEПЛОВЫЕ НАПРЯЖЕНИЯ В ЭЛЕМЕНТАХ КОНСТРУКЦИЙ in Russian No 20, 1980 (manuscript received 15 Nov 78) pp 10-15

KHOROSHUN, L. P. and BABICH, D. V., Institute of Mechanics, UkSSR Academy of Sciences

[Abstract] The fundamental equations of thermoelasticity are derived for multilayer plates and shells, on the basis of a refined theory which takes into account elastic "reduction" as well as thermal expansion across the thickness and on the basis of Hooke's law for a stack of orthotropic layers. The three-dimensional equations of elasticity are reduced to two-dimensional ones and added to the differential equation of thermoelastic equilibrium. In the case

of a uniform temperature distribution across the thickness of a double-layer panel this theory yields a state of stress and strain with parameters equal to those based on the hypothesis of an invariable straight normal. References 5 Russian.
[111-2415]

UDC 539.3:534.1

ELECTROELASTICITY RELATIONS FOR PIEZOCERAMIC SHELLS POLARIZED ALONG ONE COORDINATE AXIS

Kiev TEПЛОВЫЕ НАПРЯЖЕНИЯ В ЭЛЕМЕНТАХ КОНСТРУКЦИЙ in Russian No 20, 1980 (manuscript received 20 Oct 78) pp 3-6

BORISEYKO, V. A., MARTYSENKO, V. S. and ULITKO, A. F., Institute of Mechanics, USSR Academy of Sciences; Kiev Institute of Commerce and Economics

[Abstract] The electroelasticity relations are derived for thin piezoceramic shells fully covered with nonrigid electrodes on both inside and outside surfaces, and polarized along one of the coordinate axes in a system of orthogonal curvilinear coordinates. Such a shell is considered under uniform tension, with independent shear, and pure flexure at the ends. The analysis is based on the Kirchhoff-Love hypotheses. Expressions are obtained for the parameters of the electrostatic field and the mechanical field, to which the equations of equilibrium or motion can be added to completely describe the piezoelectric effect. References 7 Russian.
[111-2415]

UDC 624.046:074.4

EXPERIMENTAL STUDY OF LONGITUDINAL FLEXURE OF IMPERFECTLY SHAPED CYLINDRICAL SHELLS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 10, Oct 81 (manuscript received 9 Dec 80) pp 135-137

IL'IN, V. A., candidate of technical sciences, docent

[Abstract] An experimental study was made of cylindrical shells, to determine the effect of shape irregularity, due to simulated manufacturing imprecision, on their longitudinal flexure. The shell models, 0.3 m in diameter, were made of AVAT aluminum alloy with length-to-radius ratio $L/R = 1.6$ and radius-to-thickness ratio $R/h = 300-350$. The shape irregularity was measured in terms of the difference between ideal radius and mean radius at the most vulnerable section subject to maximum deflection. The results show that the ratio of this

difference under the critical load to the maximum difference under no load can serve as a stability criterion for such shells under compression or for estimating the critical load, also as a measure of manufacturing quality. Figure 1, references 2 Russian.

[100-2415]

UDC 620.1

THICK-WALLED CYLINDER UNDER LINEARLY VARYING PRESSURE

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 10, Oct 81 (manuscript received 29 Dec 80) pp 133-135

ABEL', V. V., doctor of technical sciences, professor, and STEPANOVA, A. R., candidate of technical sciences

[Abstract] A thick-walled cylinder is considered under internal and external pressure varying symmetrically and linearly along the generatrix. The corresponding axisymmetric problem of elasticity is solved in cylindrical coordinates on the basis of one fundamental stress function, rather than by the much more unwieldy method of two harmonic functions, which yields a simple expression for the radial displacements. This method can be extended to arbitrarily varying pressures, also to flexure of a thin annular plate under bending moments uniformly distributed over its inside and outside contours. Figure 1, references 2 Russian.

[100-2415]

UDC 529.3

ALGORITHM OF CALCULATING STATE OF DEEP SHELLS OF REVOLUTION WITH LARGE AXISYMMETRIC DISPLACEMENTS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 10, Oct 81 (manuscript received 25 Apr 80) pp 12-15

KOROVAYTSEV, A. V., candidate of technical sciences

[Abstract] An algorithm is proposed for calculating the state of stress and strain in deep shells with large axisymmetric displacements. The shell is subdivided into segments and the resultant ill-conditioned problem is solved by modular elimination that reduces the order of the resolvent algebraic equations and avoids the difficulty due to a generally nonquasi-diagonal matrix with floating column. The new algorithm is demonstrated on a hemispherical shell with variable number of segments for calculations on a BESM-6 computer for a wide range of displacements. The algorithm is particularly suitable for design

of displacement diaphragms, also involving numerical integration of differential equations. Figures 3, references 4 Russian.
[100-2415]

UDC 539.384:624.073

SOLVABILITY PROOF FOR PROBLEMS IN THEORY OF ORTHOTROPIC SHELLS OF REVOLUTION
WITH FINITE RIGIDITY

Kiev PRIKLADNAYA MEKhanika in Russian Vol 17, No 12, Dec 81
(manuscript received 18 Jul 80) pp 122-125

MEDVEDEV, N. G. and YEMEL'YANENKO, V. V., Institute of Mechanics, UkSSR
Academy of Sciences, Kiev

[Abstract] The solvability of problems in nonclassical theories of shells and the convergence of such methods as the Ritz-Galerkin method are analyzed in application to orthotropic shells describable by a shear model. Both are closely linked to the constrainability of some symmetric bilinear mode shaped by the strain (potential) energy. A theorem to this effect is proved, on the basis of five premises regarding the geometrical characteristics of a shell and the mechanical characteristics of its material. Application of this theorem and finding the appropriate operator involves solution of a homogeneous system of partial differential equations. The latter can be solved by the method of separation of variables. For illustration, it is demonstrated that there exists a unique solution to a specific problem of the state of stress under an external load with constraints on displacements. References 10: 9 Russian, 1 Western.
[113-2415]

UDC 539.3

FATIGUE AND STABILITY OF SHELLS OF REVOLUTION UNDER CYCLIC THERMOMECHANICAL
LOAD

Kiev PRIKLADNAYA MEKhanika in Russian Vol 17, No 12, Dec 81
(manuscript received 16 Jul 79) pp 118-121

BONDAR', V. S. and SANNIKOV, V. M., Kaliningrad (Moscow Oblast)

[Abstract] The elastic-plastic deformation of shells of revolution under cyclic thermomechanical loads is usually described according to the theory of plastic flow, taking into account the possibility of stress relaxation after plastic deformation. The state of fatigue in terms of the number of cycles until fracture and the stability of a shell in terms of the critical load have been determined for various shells according to this theory, modified

by Masing, and with the total work of microstresses serving as the criterion of fracture. Here the results are compared with experimental data on truncated conical shells alternately heated to $+850^{\circ}\text{C}$ and cooled to -100°C and cylindrical shells under alternating lateral pressure or under tension-compression cycles, shells made of D16AT duralumin or AMg-6 aluminum-magnesium alloy. The agreement is found to be close. Figures 5, tables 3, references 6 Russian. [113-2415]

UDC 539.3

STABILITY OF REINFORCED CONICAL SHELLS

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 17, No 12, Dec 81
(manuscript received 27 Nov 80) pp 70-75

SANNIKOV, Yu. A., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] A closed shell forming a frustum of a circular cone and under uniform external pressure combined with axial compression is to be reinforced with an array of crossing hoops and stringers. While the Kirchhoff-Love theory of thin elastic shells applies to the sheath, the Kirchhoff-Clebsch hypotheses for thin curvilinear beams apply to the reinforcement members. The subcritical state of stress and strain of this structure is assumed to be moment-free. The stability analysis is based on a system of three differential equations for orthotropic shells. The critical load is determined from the system of two algebraic equations to which those stability equations have been reduced according to the Bubnov-Galerkin method. The algorithm has been programmed in FORTRAN-4 for an M-4030 small computer. Typical results are shown for a shell on hinge supports at both ends, with hoops and stringers made of the same material as the sheath and having rectangular cross sections all. On the basis of its application to smooth shells, the accuracy of this method is estimated to be within 5%. Figures 3, references 8 Russian. [113-2415]

UDC 539.3

COMPUTER-AIDED NUMERICAL SIMULATION OF CERTAIN CLASSES OF PROBLEMS PERTAINING TO FLEXIBLE SHELLS OF INTRICATE SHAPE

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 17, No 12, Dec 81
(manuscript received 6 Feb 80) pp 65-69

SHINKAR', A. I., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] Nonlinear one-dimensional boundary-value problems involving large deflections are considered for two kinds of shells of revolution: axisymmetric shells with meridian of arbitrary shape and infinitely long cylindrical shells

with cross section of arbitrary shape. The state of stress and strain in both is described by a system of nonlinear sixth-order ordinary differential equations of the same general form, solvable only by numerical methods. The procedure is demonstrated on two specific problems which have been solved with the aid of an M-220 small computer. One example is an infinitely long corrugated cylindrical panel with rigidly clamped meridional edges under uniformly distributed surface load, the guide shell varying sinusoidally relative to the reference circle. The other example is a structure consisting of two cylinders of different radii and length connected coaxially through a transition cone and a torus one each side. Figures 3, table 1, references 11 Russian.
[113-2415]

UDC 539.3

THEORY OF ANISOTROPIC SHELLS AND PLATES

Kiev PRIKLADNAYA MEKhanika in Russian Vol 17, No 12, Dec 81
(manuscript received 15 Nov 79) pp 57-64

NEMCHINOV, Yu. I., Scientific Research Institute of Structural Components,
USSR Gosstroy, Kiev

[Abstract] An engineering theory of anisotropic shells and plates is proposed which includes not only strains classically accounted for, but also transverse shearing and compressive strains as well as normal stresses. The equations of equilibrium and boundary conditions in this theory are derived with the aid of the generalized variational principle and Lagrange multipliers. A shell of arbitrary shape is referred to a system of hybrid curvilinear coordinates. The resulting equations in forces and in displacements are of higher order than classical equations. For a rectangular plate on hinge supports, the system of differential equations splits into two eighth-order subsystems. Numerical data indicate close agreement with classical theory for thin plates with ratio of shear moduli of transversely isotropic material $G/G' < 1.2$, but increasingly larger deflections than according to other theories for thicker plates with larger G'/G ratios. Table 1, references 12 Russian.
[113-2415]

SOLVING CONTACT PROBLEMS IN SHELL THEORY BY ASYMPTOTIC INTEGRATION METHOD

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian
No 11, Nov 81 (manuscript received 4 Jun 80) pp 36-40

BOZHKOVA, L. V., candidate of technical sciences, docent, IL'INA, L. G.,
instructor, and NEVEL'SKAYA, T. P., candidate of technical sciences, docent

[Abstract] A spherical shell is considered that is filled with fluid and in contact with a rigid spherical cradle. The contact area and the distribution of contact stresses as well as the state of stress and strain in the shell within and beyond the contact zone are calculated on the basis of the zero-moment theory. The corresponding equations for forces and displacements, with physical and geometrical relations as well as a zero shearing force within the contact zone taken into account, are solved by the method of asymptotic integration. Graphs are plotted for specific values of a parameter which combines the geometrical characteristic of the shell (radius-to-thickness ratio) and one physical property of the material (Poisson ratio), with a given clearance, i.e., difference between cradle radius and initial shell radius. Figures 3, references 2 Russian.
[120 2415]

UDC 539.3

DESIGNING COMPOUND SHELLS OF REVOLUTION FOR LARGE DISPLACEMENTS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian
No 11, Nov 81 (manuscript received 20 Jun 79) pp 32-35

KOROVAYTSEV, A. V., candidate of technical sciences

[Abstract] The nonlinear boundary-value problem for compound thin shells of revolution with large displacements is formulated on the basis of a universal resolvent system consisting of six differential equations in forces and displacements with nine auxiliary algebraic relations which also include strains. The coefficients in this system are determined by the initial shape of the shell segments (cylindrical, conical, spherical, toroidal) and by the applicable nonlinear theory (quadratic or other). Typical solutions are shown graphically for a spheroconical shell and a spherotoroidal shell. Figures 3, references 2 Russian.
[120-2415]

CRITICAL PRESSURE FOR SHARPLY CONVEX ASYMMETRIC SANDWICH SHELL

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian
No 11, Nov 81 (manuscript received 27 Sep 80) pp 27-31

KOBELEV, V. N., doctor of technical sciences, professor

[Abstract] The loss of stability under uniform overpressure is evaluated, in terms of critical pressure, for a sharply convex sandwich shell on supporting legs of different thickness and material. The structure is assumed to be asymmetric, the filler between the plates is assumed to remain uncompressed but subject to normal shear only. An expression for the critical pressure is derived with the aid of the Euler-Poisson equation, by the method of A. V. Pogorelov ["Geometrical Theory of Stability of Shells", Izdatel'stvo "Nauka", Moscow, 1966]. Figure 1, reference 1 Russian.
[120-2415]

UDC 539.3

STRESSES AND DISPLACEMENTS IN CYLINDRICAL SHELLS UNDER LOCAL LOAD

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian
No 11, Nov 81 (manuscript received 7 Jul 80) pp 22-26

SKOPINSKIY, V. N., candidate of technical sciences, and SAFRONOV, A. A.,
graduate student

[Abstract] An experimental study was made to determine the distributions of stresses and strains in cylindrical steel shells under a local load. The shells were $L = 90$ mm long, turned to outside radius $R = 75$ mm and wall thickness $h = 1.5$ mm. For testing such a shell was fastened with its bottom to a base plate (thickness H), whereupon a radial load was applied to it 2 mm away from the free end by means of a screw mechanism through a cylindrical rod with a tapered tip. Subsequent evaluation of the strain gage data by calculations normalized to the ratios L/R , R/h and H/h reveals the effect of shell proportions and of the mounting plate on the state of stress and strain. The results can be useful for designing shells with various boundary constraints. Figures 2, table 1, references 4 Russian.
[120-2415]

EXPERIMENTAL-THEORETICAL STUDY OF DYNAMIC CHARACTERISTICS OF CONICAL SHELLS REINFORCED WITH VARIABLE-STIFFNESS STRINGERS

Kiev PROBLEMY PROCHNOSTI in Russian No 11, Nov 81
(manuscript received 2 Sep 80) pp 51-55

GRISHCHAK, V. Z., PETROV, V. V., PISANKO, A. N. and SELIVANOV, Yu. M.,
Dnepropetrovsk State University, Dnepropetrovsk

[Abstract] The dynamic characteristics of reinforced conical shells were studied by an experimental-theoretical procedure very effective for engineering analysis and design purposes. The experimental procedure combines the method of holographic averaging and the method of speckle structures associated with spottiness of laser irradiation. The theoretical procedure involves solving an intricate boundary-value problem for a system of partial differential equations of elliptical kind with variable coefficients containing Dirac δ -functions and calculating the modes and frequencies of natural vibrations by the asymptotic method, the only available practical one, with the discreteness of reinforcing elements fully taken into account. In the study of conical shells with variable-stiffness reinforcing stringers made according to these procedures, subharmonics were carefully eliminated in measurements and calculations were based on the approximation of orthotropic structures. The algorithm has been programmed in ALGOL for an M-222 small computer. The results, with various taper angles ($45-75^\circ$) and with various numbers of stringers (4-32) agree within 20%. Figures 5, table 1, references 7 Russian.
[117-2415]

STABILITY OF CONICAL SHELL UNDER COMPOUND LOAD

Kiev PROBLEMY PROCHNOSTI in Russian No 11, Nov 81
(manuscript received 3 Oct 80) pp 40-45

KARPOV, N. I. and KARPOVA, O. A., Kiev Automobile and Highway Institute

[Abstract] Circular conical shells with smaller upper base and larger lower base are considered under both axial compression and uniform external pressure, both ends covered with lids and one end either freely supported or hinge-supported. The problem of evaluating the stability limits of the state of stress and strain is reduced to finding the nontrivial solution to the homogeneous fundamental equations which will satisfy zero-value boundary conditions at the edges. The problem is solved through expansion in a series with respect to the small parameter $\sin \alpha$ characterizing the taper or deviation from a cylindrical shell with the smaller base. The method yields the mode of stability loss with any desired accuracy. It has been used for calculating the relation

between critical hydrostatic pressure and axial compression force at various taper angles. Figure 1, references 2 Russian.
[117-2415]

UDC 621.165:539.3

STRESSED STATE IN HOLE ZONE UNDER SHROUDS OF STEAM TURBINE BLADES

Kiev PROBLEMY PROCHNOSTI in Russian No 10, Oct 81
(manuscript received 5 Jan 80) pp 109-112

LUKINA, E. V., Institute of Railway Transportation Engineers, Khar'kov

[Abstract] The stresses in the zone of holes under the shrouds of steam turbine blades were studied experimentally by the photoelasticity method. A blade was simulated by a 110 x 250 mm plate 20 mm thick made of optically sensitive ED-20 epoxy resin, disregarding the slight curvature, with an oblique circular cylindrical hole. These model plates were subjected to torsion about the axis perpendicular to the plane of symmetry containing the hole axis, with the inside wall around the hole and the plane surfaces of the plate remaining load-free. An analysis of the results reveals a sinusoidal distribution of circumferential stresses around the hole, referred to the maximum shearing stress, with period of 180° and amplitudes equal to a polynomial function of the ratio of plate thickness to hole diameter. It also reveals that the amplitudes of these stresses increase and shift around the center as the hole becomes more oblique. Figures 4, references 8: 6 Russian, 2 Western.
[116-2415]

UDC 624.046:624.012.6

EXPERIMENTAL EVALUATION OF SHAPE IMPERFECTION AND CARRYING CAPACITY OF HEMISPHERICAL GLASS SHELLS

Kiev PROBLEMY PROCHNOSTI in Russian No 10, Oct 81
(manuscript received 26 Nov 80) pp 91-95

ZOLOTAREV, P. F., Institute of Strength Problems, UkSSR Academy of Sciences, Kiev

[Abstract] An experimental method has been devised for determining the initial deflections of molded hemispherical glass shells and the effect of this imperfection on the carrying capacity of spherical shells consisting of two such halves joined together. The distances from points on the median surface to the origin of a reference system of spherical coordinates are measured with a special instrument which consists of a stationary heavy ring and two rigidly coupled arches rotating on shafts. The surface profile, revealing the maximum

initial deflections, is then calculated relative to the center of a perfect hemisphere according to an algorithm which has been programmed in FORTRAN. With these data available, the carrying capacity of such hemispherical shells held pairwise together by epoxy cement and metal connectors was evaluated by recording the defectiveness at increasingly higher pressure levels. Fracture was indicated by a sharp spontaneous drop of pressure from the maximum level reached, with attendant hydroacoustic shock. The experimental results are then compared with theoretical results for perfect integral glass shells without seams. Figures 2, references 4 Russian.
[116-2415]

UDC 539.374

STATE OF THERMOELASTOPLASTIC STRESS IN OPEN SHELLS OF REVOLUTION UNDER
NONAXISYMMETRIC MECHANICAL AND THERMAL LOADS

Kiev PROBLEMY PROCHNOSTI in Russian No 10, Oct 81
(manuscript received 3 Oct 80) pp 88-91

MERZLYAKOV, V. A., Kiev

[Abstract] The thermoelastoplastic stresses in a thin open cylindrical shell under nonaxisymmetric force and heat load are determined, assuming the Kirchhoff-Love hypothesis to be applicable and mechanical properties of the material to be temperature dependent. Calculations are based on the theory of small elasto-plastic strains and the corresponding equations, with all quantities characterizing deformation expressible in trigonometric series. The example of a cylindrical panel on hinge supports is considered, either stationary or circumferentially free, under a radial force acting on the inside surface uniformly distributed along the generatrix and cosinusoidally varying around the circumference. This panel is heated uniformly along the generatrix and nonuniformly around the circumference as well as across the thickness. Typical results are shown for such a panel made of EI395 steel. Figures 3, references 5 Russian.
[116-2415]

UDC 539.3

NONAXISYMMETRIC LONGITUDINAL-TRANSVERSE DEFLECTION OF CYLINDRICAL SHELLS
UNDER COMBINED PURE FLEXURE AND PRESSURE

Kiev PROBLEMY PROCHNOSTI in Russian No 10, Oct 81
(manuscript received 12 Aug 80) pp 83-88

ALTUKHER, G. M., Khar'kov, and YEVLANOV, V. V., Moscow, All-Union Scientific-Industrial Association "Soyuzturbogaz"

[Abstract] An elastic circular cylindrical shell is loaded by a bending moment and nonuniform pressure, the latter combining uniform axial compression and

excess internal pressure. The state of stress and strain of such a shell is calculated by the energy method and with the aid of Fourier series expansions, assuming symmetric load and hinge supports at both ends. Numerical results, including deflection and critical load corresponding to loss of stability, have been obtained in dimensionless form for a typical shell of relative length $\frac{L}{D} = \pi$ made of a material characterized by Poisson ratio $\nu = 0.3$ and sonic velocity $c^2 = 10^5$. Figures 2, tables 3, references 4 Russian. [116-2415]

UDC 666.1.054

PREDICTING BREAKING EXTERNAL HYDROSTATIC PRESSURE ON SPHERICAL GLASS SHELLS

Kiev PROBLEMY PROCHNOSTI in Russian No 9, Sep 81
(manuscript received 9 Oct 80) pp 80-84

D'YACHKOV, I. I., Institute of Strength Problems, UkSSR Academy of Sciences, Kiev; DOBROMYSLOV, N. N., Moscow Power Engineering Institute

[Abstract] A compound spherical glass shell consisting of two hemispherical segments joined at their bases with an adhesive seam is considered to be under external hydrostatic pressure, i.e., immersed in water. Assuming that the material has random mechanical properties so that the breaking level of pressure is also a random quantity, the strength of such a shell is calculated as the probability of withstanding a given pressure load. The calculations are based on stress analysis, with the shell subdivided into finite homogeneous elements, and on the Weibull distribution of fracture probability. This method of analysis is applied to a real shell made of MKR-1 glass with wall thickness of 5.5 mm. Figures 7, references 9 Russian. [118-2415]

UDC 539.4

POSSIBLE MODE OF VIBRATION EXCITATION IN COMPRESSOR BLADES

Kiev PROBLEMY PROCHNOSTI in Russian No 9, Sep 81
(manuscript received 30 May 80) pp 78-80

BAVEL'SKIY, D. M., BOGORADOVSKIY, G. I. and ROMANYCHEV, M. S., Nevskiy Manufacturing Plant imeni V. I. Lenin, Leningrad

[Abstract] Excitation of natural vibrations in blades of 2-shaft axial compressors with oppositely rotating runners is analyzed, stream nonuniformity and resulting perturbations at any given row of blades being produced by rows ahead and rows behind as well as by laminar trails. The experimental compressor

had two rows of blades on each shaft and no stationary guide vanes for the second row on each wheel. There were 30 blades made of duralumin in each row and 38 stationary guide vanes for the first row on each wheel. The speeds of both wheels were varied, one from 138 to 165 rps and one from 60 to 180 rps, to provide a wide range of flow rates and pressure heads. Frequency and amplitude measurements have revealed that the speeds of both wheels can always be matched so as to induce resonance in any given blade. A relation is derived on the basis of experimental data for frequency of the harmonic of the excitation force that can induce resonance at nonmultiple speeds, this frequency being equal to some combination of the two speeds. Figures 2, table 1, references 3 Russian. [118-2415]

UDC 539.3

NATURAL VIBRATIONS OF RHOMBOIDAL CYLINDRICAL PANELS

Kiev PROBLEMY PROCHNOSTI in Russian No 9, Sep 81
(manuscript received 4 Jul 80) pp 71-75

BEL'YANOVSKIY, Ye. S. and PUKHLIY, V. A., Central Scientific Research Institute of Industrial Buildings, USSR Gosstroy

[Abstract] Natural vibrations of rhomboidal cylindrical panels clamped around all four edges are evaluated on the basis of linear formulation of the problem. Tangential and normal inertia forces are included in the Vlasov equations for shallow shells. These dimensionless differential equations are solved by the Bubnov-Galerkin variational method with affine transformation of domains and in an oblique system of coordinates. The calculations, in the binomial approximation, have been programmed in FORTRAN-4 for an M-4030 small computer. The results are compared with those obtained by other methods such as the Rayleigh-Ritz method or with the use of beam functions, a square plate and a 30° rhombic plate serving as test cases. Figures 3, tables 2, references 10: 5 Russian, 5 Western. [118-2415]

STABILITY AND CARRYING CAPACITY OF LONGITUDINALLY BRANCHING CYLINDRICAL SHELLS UNDER CENTRAL OR ECCENTRIC COMPRESSION

Kiev PROBLEMY PROCHNOSTI in Russian No 9, Sep 81
(manuscript received 29 Apr 80) pp 55-59

LIPOVSKIY, D. Ye., NAZAROV, V. A., SUTLOV, V. V. and SHAPKO, V. I.,
Khar'kov Institute of Structural Engineering

[Abstract] The stability and carrying capacity of longitudinally branching cylindrical shells, open under uniform compression along generatrices and closed under eccentric compression, were studied both theoretically and experimentally. A branching shell can be regarded as a multilink chain of panel elements coupled along their lateral edges. Calculations were made on the basis of linearized equations in components of the displacement vector, with differential operators in the corresponding square matrix for the boundary-value eigenvalue (critical loads) problem, and on the basis of stress diagrams plotted according to the moments method. Measurements were made on nine specimens in three sizes, with grade VSt3PS5 class S38/23 steel as the material. The results indicate that reinforcement of cylindrical shells with longitudinal panels increases both their carrying capacity and stability, the critical stress becoming 2.5-3 times higher at the cost of only 30% more material. Such shells, moreover, do not fracture instantaneously after loss of stability. Figures 3, tables 2, references 5 Russian.
[118-2415]

UDC 539.374+539.377

STABILITY OF CYLINDRICAL SHELL UNDER EXTERNAL PRESSURE AND NONUNIFORM HEATING

Kiev PROBLEMY PROCHNOSTI in Russian No 9, Sep 81
(manuscript received 4 Jul 80) pp 53-55

LEBEDEV, A. G., Dnepropetrovsk State University, Dnepropetrovsk

[Abstract] Cylindrical shells under uniform external pressure and nonuniform heating are considered, with geometrically nonlinear deformation characterized by the deflection function

$$w = w(\varphi) \sin \frac{\pi x}{L} \quad (\varphi - \text{circumferential coordinate,}$$

x -longitudinal coordinate, L - length of shell) and nonuniform heating characterized by temperature distribution

$$T = T_{\max} \frac{1}{1 + (a\varphi)^4} \quad (a - \text{constant determining}$$

the degree of heat localization). The effect of heating nonuniformity on the stability of such a shell made of aluminum-magnesium alloy has been evaluated

numerically on the basis of the corresponding boundary-value problem involving a system of nonlinear ordinary differential equations with variable coefficients, the solution being closed with respect to circumferential coordinate. The inside surface of the shell was assumed to remain cold, with the temperature varying linearly across the wall thickness. The critical load, always lower under combined heat and pressure loads than under pressure load alone, is found to depend nonmonotonically on the heating nonuniformity: the critical load (30% lower than for an axisymmetrically heated shell and 40% lower than for a cold shell) corresponds to resonance with respect to subcritical deflection and stability loss. Figures 2, references 4 Russian.
[118-2415]

UDC 621.792.8

STRENGTH AND DAMAGEABILITY OF COMPOUND GLASS SHELLS WITH VARIOUS TYPES OF SEPARABLE CONNECTIONS

Kiev PROBLEMY PROCHNOSTI in Russian No 9, Sep 81
(manuscript received 3 Dec 80) pp 46-53

KVITKA, A. L. and D'YACHKOV, I. I., Institute of Strength Problems,
UkSSR Academy of Sciences, Kiev

[Abstract] A comparative evaluation was made of separable and movable connections between glass shells under external hydrostatic pressure. Various assemblies of spherical and cylindrical shells made of grade MKR-1 glass with approximately the same wall thickness at the edges (ground down to 10.90-11.05 mm with class-3 precision) were tested for strength and damageability under single momentary, cyclic alternating, and constant loads. The halves were joined either directly with glass-to-glass contact with cold-setting cement (ED-16 epoxy resin + polyethylene-polyamine hardener) or through various metal connectors with rubber seals. Direct connection of shells and metal connectors, either with solid glass-to-metal contact or with hinging, were found to be inadequate under cyclic loads and in the case of metal connectors also under constant loads. The new design of a connector with metal flange whose rigidity exceeds the carrying capacity of the entire shell structure ensures ultimate strength of 1600 kgf/cm² for spherical shells and 1400 kgf/cm² for cylindrical shells, with reliability margin of 600 kgf/cm² in 100 cycles (1000 kgf/cm² maximum in a cycle). Figures 5, references 5 Russian.
[118-2415]

APPROXIMATE MATHEMATICAL MODELS FOR STABILITY PROBLEMS PERTAINING TO NONHOMOGENEOUS SHELLS

Moscow IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 9, Sep 81 (manuscript received 4 Mar 80) pp 14-17

ANDREYEV, L. V., doctor of technical sciences, professor, LEBEDEV, A. G., candidate of technical sciences, and OBODAN, N. I., candidate of technical sciences

[Abstract] The stability problem is considered for a cylindrical panel under uniform pressure with either smooth transformation of the subcritical flexure mode to an even number of half-waves or bifurcation of the initial state to an odd number of half-waves depending on its width. The effect of simplifying approximation, namely linearization of the torqued subcritical state, on the accuracy of the solution is examined relative to the resonance-type dependence of the critical load on the enclosure angle in the exact nonlinear formulation. The extreme cases of free supports and stationary hinge supports, with a stiffening effect, along the lateral panel edges are considered as well as the load discontinuity at those edges. The linear model is found to valid only for loads and constraints under which the amplitude of the subcritical deflection curve remains small. Figures 3, references 3 Russian.
[99-2415]

PARAMETERS OF OPTIMUM REINFORCEMENT FOR CYLINDRICAL SHELL WITHIN ZONE OF CONCENTRATED ACTION

Moscow IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 9, Sep 81 (manuscript received 18 Mar 80) pp 6-10

UZHVA, V. V., assistant

[Abstract] Optimum hoop reinforcement of a cylindrical shell under a concentrated radial load is considered, minimum mass of the reinforcement member being the target. The state of stress and strain in the structure is calculated by the method of finite elements, a curvilinear element of the shell having twelve degrees of freedom. The optimization problem is formulated as one in nonlinear programming, to be solved numerically by a modification of the method of steepest descent. The critical load is then determined, in terms of axial and circumferential membrane forces as well as shearing force due to twist. This algorithm has been applied to shells made of Kh18N9T strip steel with a welding seam and a reinforcing hoop with rectangular or circular cross section around the outside surface. A closed hoop of uniform stiffness as well as open hoops of variable stiffness in the form of arcs subtending various angles and including

stepwise reinforcement have been considered. In a typical case the optimum reinforcement was found to weigh 27 times less than a hoop of uniform stiffness, the latter being required when much lower stresses are allowed than in the shell. Figures 2, tables 1, references 7 Russian.
[99-2415]

UDC 534.0

INFLUENCE OF AMBIENT TEMPERATURE ON RATIONAL DESIGN OF DYNAMIC VIBRATION DAMPERS WITH VISCOELASTIC COUPLING

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian
No 8, Aug 81 (manuscript received 23 Jan 80) pp 148-150

BRISKIN, Ye. S., assistant

[Abstract] Experience has shown that elastic and dissipative properties of viscoelastic materials such as rubber and plastics used for vibration dampers depend on ambient temperature. A design method is needed, therefore, and one is shown here which takes into account the influence of temperature variation on performance characteristics. The frequency ratio and dissipation factor are specifically affected. Accordingly, rational values of these two parameters are selected so as to minimize the increase in the modulus of the dynamic load factor at resonance due to variation of the actual values of these parameters over the given range. The modulus of the dynamic load factor is calculated by the method of invariant points. The procedure is demonstrated on a vibration damper made of fiberglass plastic and designed for operation at ambient temperatures from 20 to 50°C. It yields a better design than does the conventional procedure based on mean (in terms of the logarithmic amplitude decrement) temperature. Figure 1, references 5 Russian.
[101-2415]

UDC 539.3:534.1

TRANSMISSION OF TORQUE TO SHELL THROUGH ONE-DIMENSIONAL INCLUSION

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian
No 8, Aug 81 (manuscript received 25 Jan 80) pp 3-6

OL'SHANSKIY, V. P., candidate of technical sciences

[Abstract] A thin-walled shallow isotropic shell panel is considered with a one-dimensional inclusion in the form of a reinforcement bar. The transmission of torque through this bar to such a panel that twists the former and bends the latter is analyzed on the basis of the equilibrium condition for a perfectly rigid bar. The problem reduces to determining the angle of rotation of the bar

and distribution of the moment density over the line of reinforcement. Calculations involve evaluation of improper integrals for the appropriate Green function and solution of a Fredholm equation of the second kind. A solution of sixth-order accuracy is obtained for relatively short reinforcing bars, since real longer bars cannot be regarded as perfectly rigid, and an expression is obtained for compliance of the joint as a function of panel stiffness and bar length. Table 1, references 7 Russian.
[101-2415]

UDC 539.383

DETERMINING CONTACT ZONE AND CONTACT STRESSES IN PAIR OF INTERNALLY TANGENT CYLINDERS

Moscow MASHINOVEDENIYE in Russian No 6, Nov-Dec 81
(manuscript received 25 Mar 81) pp 75-81

USOV, P. P., Moscow

[Abstract] The problem of contact between two elastic cylinders, one inside another, is solved by a modification of the Multhopp method. A full solution is obtained without limiting the values of the Poisson ratio and of the Young modulus. The model is an isotropic elastic medium with horizontal circular hole in which an elastic cylinder with a smaller radius rests. A concentrated vertical force passing through both axes presses the inner cylinder against the inside surface of the outer one. The corresponding dimensionless integrodifferential equation is solved for distribution of contact stress over the contact arc, and for the angle subtended by the latter, assuming equilibrium and absence of friction. The solution is facilitated by replacing the Hilbert kernel with a Cauchy kernel, through appropriate substitution of variables. The results reveal that the angle of contact under a force of any positive magnitude after zero initial clearance between given cylinders is always the same, equal to and never larger than it would be at the limit under an infinitely large force after finite initial clearance between them. The stress distribution can be calculated numerically by computer. Figures 2, tables 2, references 9 Russian.
[102-2415]

NATURAL FREQUENCIES AND MODES OF REINFORCED AXISYMMETRIC SHELLS

Rostov-na-Donu IZVESTIYA SEVERO-KAVKAZSKOGO NAUCHNOGO TSENTRA VYSSHEY SHKOLY: YESYESTVENNYE NAUKI in Russian No 3, Jul-Sep 81 (manuscript received 19 May 80) pp 32-36

YUDIN, A. S., RUKINA, T. I. and SHEVCHENKO, V. I., Scientific Research Institute of Mechanics and Applied Mathematics, Rostov-na-Donu State University

[Abstract] The fundamental equations of steady-state free vibrations for structurally anisotropic shells of revolution are, after elimination of the circumferential coordinate, put in dimensionless form suitable for calculating the natural frequencies and modes of such shells with reinforcing hoops. The shell is subdivided into segments with conditions of contact between segments along the hoops conforming to the Ostrogradskiy-Hamilton principle. The corresponding series of homogeneous boundary-value eigenvalue problems is solved by the method of differential elimination with orthogonalization. The algorithm has been programmed in FORTRAN for a BESM-6 computer. The roots of the characteristic determinant are calculated by successive halving of segments until the necessary accuracy has been reached. Seven harmonics were calculated for a cylindrical shell reinforced by 13 hoops and closed at each end by an isotropic annular plate freely supported around its inner contour. The hoops were accounted for as discrete members or were included in a continuous scheme. The respective results are compared, also with results obtained by other methods of calculation. Tables 2, references 4 Russian.
[103-2415]

UDC 539.411:620.173.22:666.1

PARTICULARS OF STRAIN AND FRACTURE WHEN EXTERNAL PRESSURE ACTS ON CYLINDRICAL PLATE GLASS SHELLS WITH ENDS CEMENTED IN GROOVES OF RIGID DISKS

Kiev PROBLEMY PROCHNOSTI in Russian No 8, Aug 81
(manuscript received 3 Dec 80) pp 53-57

GORALIK, Ye. T. and ZOLOTAREV, P. F., Kiev, Institute of Strength Problems, UkSSR Academy of Sciences

[Abstract] An investigation is made of the way that the stressed and strained state of cylindrical glass shells held in massive end blocks by epoxy cement based in ED-6 cold-setting resin is affected by the geometric dimensions of the groove in the blocks into which the ends of the shell are cemented: depth of the groove and gap between the inside wall of the cylinder and the wall of the end block. Strain gages were used to measure the relative axial strains on the inside and outside of the shell in the zone adjacent to the end blocks. The shells were loaded in a pressure chamber with engine oil as the working fluid.

Loads were increased (up to 140 kgf/cm²) and relieved in increments of 20 kgf/cm². The results show that when cylindrical shells of material with low tensile strength are cemented into end blocks, strain and breakage can be reduced by making the groove in the block 4-5 times as deep as the shell thickness, and by leaving a sufficient gap between the inside of the shell and the wall of the groove so that the cemented sections of the glass are not severely affected by turning and shifting. Figures 6, references 4 Russian.
[95-6610]

TESTING AND MATERIALS

UDC 534.11

LONGITUDINAL HIGH-FREQUENCY VIBRATION AMPLITUDES AND CORRESPONDING MECHANICAL STRESS LEVELS IN PIEZOCERAMIC CELLS

Kiev TEПЛОВЫЕ НАПРЯЖЕНИЯ В ЭЛЕМЕНТАХ КОНСТРУКЦИЙ in Russian No 20, 1980 (manuscript received 20 Sep 78) pp 94-97

BONDARENKO, A. A., Institute of Mechanics, UkSSR Academy of Sciences

[Abstract] A study was made to determine longitudinal vibration amplitudes and mechanical stress levels in piezoceramic bars. Specimens of TsTBS-3 material $10 \times 0.5 \times 0.1$ cm in size were rigidly clamped at one end only and excited at that end electrically with 93 V a.c. voltage from an audio-frequency oscillator through special contacts and electrodes. Longitudinal vibrations at resonance were measured at the free end, the frequency of the fundamental natural mode being $8.5 \cdot 10^3$ Hz. Mechanical stresses were calculated from the equation of motion and equations of the piezoelectric effect, with experimental data and the known physico-mechanical parameters of the material inserted into the solution. The tensile stress at the clamped end was thus found to be 400 kgf/cm^2 and fracture to occur after $5 \cdot 10^6$ cycles. Figures 1, references 3 Russian.

[111-2415]

UDC 621.187.3:666.29.01

COMPARATIVE STUDY OF GLASS-ENAMEL COATINGS FOR THERMOTECHNICAL APPLICATIONS

Moscow ТЕПЛОЭНЕРГЕТИКА in Russian No 12, Dec 81 pp 47-49

BAZAYANTS, G. V., candidate of technical sciences, SVETLICHNYY, V. A., candidate of technical sciences, OLEJNIK, M. I., candidate of technical sciences, DEMCHUK, V. V., engineer, RYZHIKOV, V. A., engineer, and SIROTINSKIY, A. A., engineer

[Abstract] The rated life of glass-enamel coatings is 4-6 years on pipes but only 2-4 years on oil-heated boilers. Several grades of glass-enamels, amorphous and crystalline, were tested in a comparative study to determine the causes of

premature failure. The results reveal that high resistance to acids, while necessary, is not sufficient to ensure adequate life. Structural continuity is another criterion, as indicated by the kinetics of defectiveness buildup. Most dangerous are porosity and flakiness, both relating to the formation of small to large blisters. The critical blister size depends on coating thickness as well as acid resistance of coating material. Two new grades of glass-enamel coating are being developed now, 261 and 13-111, the former more economical to produce and the latter featuring a higher degree of film continuity than the conventional A-20 grade. Figures 3, table 1, references 3 Russian.
[112-2415]

UDC 621.165-253.001.5

CHARACTERISTICS OF TURBINE STAGES WITH MEDIUM FAN-OUT AND REDUCED REACTIVITY GRADIENT

Moscow TEPLOENERGETIKA in Russian No 12, Dec 81 pp 35-38

KIRILLOV, I. I., doctor of technical sciences, LAPSHIN, K. L., candidate of technical sciences, SADOVNICHYI, V. N., candidate of technical sciences, MATVEYENKO, V. A., candidate of technical sciences, and NEZHENTSOV, Yu. N., engineer, Leningrad Polytechnic Institute; Manufacturing Engineering Department, Leningrad Metal Works

[Abstract] An experimental study was made concerning regulation of the reactivity gradient in stages of steam turbines with medium fan-out ($4 < d_2/l_2 < 8$) as means of improving efficiency. Two models with $d_2/l_2 = 6.34$ were tested for comparative evaluation. The model of a standard medium-pressure stage designed for uniform circulation had both entrance and exit edges of the guide vanes set radially. In the second model, longitudinal reactivity gradient at the periphery was reduced by combining backward twist of the guide vanes with smaller tangential slant in the direction of wheel rotation at their roots. Tests were performed first with nominal interstage clearance of 4.6 mm and then with this clearance varied from 4.6 to 19.6 mm. The effect of banded seals on the wheel and performance at near idle levels were also evaluated. The results indicate that reduction of reactivity gradient increases turbine efficiency, especially when the clearances in labyrinth seals are large, but enlargement of interstage clearance decreases turbine efficiency. Up to relative interstage clearance of 2.3, however, reduction of the reactivity gradient restores efficiency. Reduction of the reactivity gradient also improves performance at low load levels and in the ventilation mode. Figures 3, table 1, references 7 Russian.
[112-2415]

STRENGTH OF ROTATING DISKS MADE OF COMPOSITE MATERIALS

Kiev PROBLEMY PROCHNOSTI in Russian No 10, Oct 81
(manuscript received 12 Oct 80) pp 112-115

KOZLOV, I. A., YUDIN, A. B., ABRASHKEVICH, Yu. D. and BELIKOVICH, V. M.,
Institute of Strength Problems, UkSSR Academy of Sciences, Kiev

[Abstract] Grinding wheels made of composite materials are widely used for cutting and finishing of metal or nonmetallic parts. Here the results of a stress analysis of two such wheels with center holes 32 mm in diameter are presented. One wheel with an outside diameter of 300 mm consists of a mass of abrasive grains bonded together with phenol formaldehyde resin and retained between two glass-cloth meshes. Another wheel with an outside diameter of 400 mm consists of two such disks stacked together to a 4 mm thickness and thus contains three layers of glass-cloth mesh, but the two outer ones extend only over a diameter of 230 mm. Samples of such wheels were tested at 5000 and 3000 rpm respectively, under nominal loading forces applied at various angles to the base. Radial and circumferential stresses were measured with strain-gage resistors. They were found to be more than twice as high as nominal. A jump of stresses occurs in the compound wheel at the 115 mm radius, where the number of glass-cloth meshers changes from three to one. Data obtained in acceleration tests indicate that stresses at the instant of fracture are far above the tensile strength of the wheel material. Therefore, the load capacity of grinding wheels with glass-cloth mesher cannot be estimated on the basis of uniaxial tension tests alone. Figures 6; tables 1, references 2 Russian.
[116-2415]

EFFECT OF MAGNETIZATION ON INTERACTION OF RUBBING SURFACES

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian
No 9, Sep 81 (manuscript received 27 Jun 80) pp 41-45

SURANOV, G. I., candidate of technical sciences and lecturer, KOPTYAYEVA, G. B.,
senior instructor

[Abstract] An earlier experimental study has established that magnetization of machine parts such as cast-iron piston rings and carbon-steel rollers rubbing against other surfaces influences their friction and wear characteristics. Tests performed in an MI-1M friction machine in the magnetic field of the 77PMD-3M flow detector revealed a substantial reduction of wear, attributable either to the way that magnetization affects the physico-mechanical properties of the surface material of the rubbing part or to the way that the magnetic field in such a part affects properties of the lubricant. Subsequent impact tests were

performed to simulate the dynamic interaction of roughness on both rubbing surfaces. Plane surfaces of St-3 and St-45 carbon steels, either rough or polished and either dry or wetted with MS-20 (AS-8) oil, were struck by a ball made of ShKh-15 chromium steel in a magnetic field or without one. An analysis of the surface profilograms and of the lubricant pressure-viscosity characteristics indicates that both effects as well as processes in the boundary layer play a role here. Figures 2, table 1, references 6 Russian.
[99-2415]

GLASS-ENAMEL FOR PROTECTING POWER EQUIPMENT AGAINST CORROSION

Moscow ENERGETIK in Russian No 10, Oct 81 pp 30-31

GUTOV, V. G., engineer, AGAFONOV, E. T., engineer, and DRAGANIK, I. N., engineer, Siberian Special Administration for Repair of Electrical Power Equipment

[Abstract] An anticorrosion treatment plant was organized in 1978 consisting of an electric furnace and two ball mills, for coating electrical power plant equipment with glass-enamel. The process includes surface preparation by degreasing and cleaning and preparation of the enamel skim by the wet process. The latter involves grinding the frit, mixing with additives (clay, chromium oxide, molybdenum anhydride, borax, titanium dioxide, sodium nitrite, water), and aging for at least 24 h to ensure a stable mix with good adhesive characteristics. The enamel skim is then deposited on the surface, dried, and fired. Already 1000 m² of tubing and container surface for various electric power plants (Barnaulskaya, Biyskaya, Tomskaya) have been protectively coated in this manner.
[105-2415]

UDC (621.922+621.9.079):669.295.5

SELECTING TOOL AND COOLANT FOR GRINDING TITANIUM ALLOYS

Moscow STANKI I INSTRUMENT in Russian No 11, Nov 81 pp 15-17

SAYUTIN, G. I., NOSENKO, V. A. and SPIRIDONOV, D. N.

[Abstract] The selection of abrasive wheel and coolant for grinding titanium alloys is reviewed from the standpoint of product quality requirements and optimum process characteristics. El'bor borazon material and diamond wheels have highest wear resistance, while corundum wheels have lowest wear resistance and sear the surface at higher speeds. Silicon carbide with nonisometric grains and phenolic binder containing certain halides such as KBF₄ as an additive also has high wear resistance and performs very satisfactorily. The quality of surface treatment depends largely on the lubricant used. Most effective for

lubrication with cooling during rough grinding is water containing potassium (sodium) phosphate, tribasic while oil containing dibutyl trichloromethylphosphonate is most effective for lubrication with cooling during finish grinding. Certain grinding operations require no cooling and for these SiC wheels are recommended with phenolic powder bond. All recommendations are based on a comparative evaluation of these abrasives and lubricants in terms of metal (titanium alloy) removal per pass and grinding process characteristics such as temperature hot spots and vibration. Selection will also depend on initial surface condition (roughness) and final surface condition required. Figures 3, table 1, references 7 Russian.
[106-2415]

CSO: 1861

- END -

END OF

FICHE

DATE FILMED

MARCH 18, 1982